## REMARKS

Applicants respectfully request that the above application as amended be reconsidered. Claims 1-30 are currently pending.

Claims 1, 17 and 28 have been amended to specify that the method forms a controlled, relatively uniform aluminide coating on the turbine engine component, as disclosed in the specification on page 2, paragraph 0007 and in Examples 1 and 2, paragraphs 0037-0040.

Claim 15 as been amended to omit reference to step (e). Accordingly, it is requested that the rejection of this claim under 35 USC 112 be withdrawn.

Claim 16 has been amended to correct a typographical error.

No new matter is introduced by the above amendments, and it is requested that they be entered.

### A. Response to Rejection of Claims 1-7 and 11 under 35 USC 103(a) as Unpatentable over U.S. Patent 5,780,106 (Conner) in view of U.S. Patent 4,031,274 (Bessen)

Claims 1-7 and 11 have been rejected under 35 USC 103(a) as unpatentable over the '106 reference in view of the '274 reference.

1. The '106 reference is said to disclose a process of providing a turbine blade having an external surface and internal surface connected to the external surface by cooling holes, loading a coating chamber with the blade, heating the chamber to a temperature of less than $600^{O}F$, preferably 350 to $450^{O}F$, flowing a tri-alkyl aluminum coating gas such as tri-isobutyl aluminum into the heated, evacuated coating chamber for 1 to 3 hours to deposit an aluminum coating on the internal and external surfaces of the blade, and heat treating the coated component to form an aluminide coating on the internal and external surfaces of the blade.

2. It is also stated that while the '106 reference does not explicitly disclose the use of pressures in the claimed range, it is clear from the disclosure of an "evacuated" chamber that the process is conducted at below atmospheric pressure, and the use of pressures in the claimed range would have been expected to be operable. It is stated that the use of the claimed pressure would have been prima facie obvious.

3. It is also noted that the '106 reference does not explicitly disclose the temperature at which the diffusion is performed or the use of a nonoxidizing atmosphere for diffusion. However, it is stated that it would have been obvious to have used the claimed temperatures and

inert gas atmosphere because the '274 reference discloses diffusing an aluminum coating on a superalloy substrate at temperatures in the claimed range and in an inert gas atmosphere to form a diffusion aluminide coating on the blade.

Applicants respectfully traverse this rejection.

Applicants' invention is directed to forming an aluminide coating on the internal and external surfaces of a turbine component, such as a turbine blade having an internal cooling cavity. The invention is a low-temperature, low-cost process to form a controlled, relatively uniform aluminide coating on the external and internal surfaces of turbine blades and other turbine components. Prior art processes using halide containing vapors at high deposition temperatures are expensive and difficult to control, and may result in distortion of the blades, grain growth, creep, and other thermo-mechanical failure mechanisms that can decrease the strength and life of the blade. While the cited '106 and '274 references disclose various steps in Applicants' process, they do not disclose Applicants' complete process or that their processes are sufficiently controlled to provide a relatively uniform aluminide coating on the external and internal surfaces of turbine engine components.

The process of the invention forms relatively thin aluminide coatings on the internal surfaces of turbine blades, particularly in the root and shank regions, so as not to cause premature cracking in the root portion of the blade. Because stresses generated during engine operation may be induced into the root portion, limiting the thickness of the aluminide coating to less than about 0.0015 inches (about 38.1 microns) on the internal surface within the root portion facilitates preventing material degradation and cracking within the root portion, which contributes to maintaining the fatigue life of the blade. The '106 and '274 references do not disclose this particular problem, or processes that are sufficiently controlled to inherently solve the problem.

In the process of the invention, the aluminide coatings are formed by depositing a relatively uniform aluminide coating on the external <u>and</u> internal surfaces of the blade using a vapor deposition process, specifically a metal organic chemical vapor deposition (MOCVD) process. One feature of this process is that the blades upon which aluminide coatings are formed are heated to a relatively low temperature in the range of from about 240°C to about 450°C during the deposition process, a temperature well below the service operating temperature of the blades. However, this range is still above the typical 350°-400°F (about 177°C-204°C) range

disclosed in col. 3, line 49 of the '106 reference. According to the MOCVD process of the invention, the vapor produced from the reagent source chamber flows to the coating container and then around and through the turbine blades to deposit an aluminum coating upon their internal and external surfaces. The '106 and '274 references do not disclose this, or that their processes are sufficiently controlled to provide such a relatively uniform coating on the internal and external surfaces of the blade.

In summary, in Applicants' method, the thickness of the aluminum coating on the external and internal surfaces of the blade is determined by: the nature of the metal organic vapor; the pressure at which the coating gas is flowed into the coating chamber; the temperature of deposition; and the time of exposure of the blade to the metal organic vapor. The temperature, pressure, flow rate, time of exposure and atmosphere are all important parameters to produce the controlled, relatively uniform aluminide coatings according to the invention. Aside from disclosing methods for coating turbine engine components, the '106 and '274 references provide no motivation for a person of ordinary skill in the art to modify their temperature and pressure/flow rate, and atmosphere, and combine these modifications as specified in the present claims, all of which would be necessary to obtain Applicant's invention.

In addition, because stresses generated during engine operation may be induced into the root portion, limiting the thickness of the aluminide coating to less than about 0.0015 inches (about 38.1 microns) on the internal surface within the root portion facilitates preventing material degradation and cracking within the root portion, which contributes to maintaining the fatigue life of the blade. Again, this problem and its solution is not disclosed or suggested in the cited references. The invention thus provides a low-temperature, low-cost process to form a controlled, relatively uniform aluminide coating on the external and internal surfaces of turbine blades and other turbine components.

For the foregoing reasons, Applicants submit that Claims 1-7 and 11 would not have been obvious over the '106 reference in view of the '274 reference. Reconsideration and withdrawal of the rejection of Claims 1-7 and 11 is requested.

**B. Response to Rejection of Claims 8-10 and 12-30 under 35 USC 103(a) as Unpatentable over U.S. Patent 5,780,106 (Conner) in view of U.S. Patent 4,031,274 (Bessen) as applied above, and further in view of U.S. Patent 5,856,027 (Murphy)**

Claims 8-10 and 12-30 have been rejected under 35 USC 103(a) as unpatentable over the '106 and '274 references in view of the '027 reference.

1. While acknowledging that the '106 and '274 references do not disclose the step of forming an alumina coating by exposing the aluminide coating to an oxidizing atmosphere at the claimed temperatures, it is stated that it would have been obvious to have formed an alumina coating in this manner in light of the '027 reference, disclosing an adherent alpha alumina coating by oxidizing a diffusion aluminide coating at the claimed temperatures to provide a coating for receiving a ceramic thermal barrier coating.

2. Lastly, while acknowledging that the above references do not disclose the thickness of the aluminide coating, it is said that deposition of the aluminide coating to thicknesses in the claimed ranges would have been obvious in light of the disclosure of the '027 reference.

Applicants respectfully traverse this rejection.

The '027 reference discloses a thermal barrier protected nickel based or cobalt based superalloy component for use in a gas turbine engine which includes a thermal barrier coating system having a multi-layered structure. In the '027 reference, an adherent alumina layer is formed on the diffusion aluminide layer by oxidizing the outer layer region in a low partial pressure oxygen atmosphere at a temperature greater than about 1800$^{O}$F that promotes in-situ formation of alpha alumina.

However, as described above regarding the other references, the '027 reference does not teach the precise combination of temperature, pressure/flow rate, exposure time, and atmosphere conditions needed to arrive at Applicants' process. As noted above, the invention overcomes the disadvantages of the prior art by providing a low-temperature, low-cost process to form a controlled, relatively uniform aluminide coating on the external and internal surfaces of turbine blades and other turbine components. In addition, the process of the invention forms relatively thin aluminide coatings on the internal surfaces of turbine blades, particularly in the root and shank regions, so as not to cause premature cracking in the root portion of the blade. When exposed to a high-temperature oxidizing environment, the aluminum-enriched layer at the

external surface oxidizes to form an adherent aluminum oxide protective scale at the external surface, which inhibits and slows further oxidation damage.

These advantages and improvements over the prior art are not disclosed in the '027 reference, nor is there any suggestion or teaching in the '027 reference that would lead one of skill in the art to the invention. Furthermore, there is no disclosure in the '027 reference that would suggest combining it with the '106 or '274 references to arrive at Applicants' invention. In fact, the portion of the '027 reference cited by the Examiner at col. 5, lines 1-20 describes a process using halide vapor (aluminum trichloride according to col. 4, line 67) at high deposition temperature (1000$^{O}$C according to col. 5, lines 2-3). As noted on page 2, paragraph 0007 of Applicants' specification, processes using halide containing vapors at high deposition temperatures can be expensive and difficult to control, and may result in distortion of the blades, grain growth, creep and other thermo-mechanical failure mechanisms that can decrease the strength and life of the blade.

For the foregoing reasons, Applicants submit that Claims 8-10 and 12-30 would not have been obvious in light of the above references. Reconsideration and withdrawal of this rejection is requested.

## C. Conclusion

It is believed that the above represents a complete response to the Examiner's rejections and places the application in condition for allowance. Accordingly, reconsideration and allowance of Claims 1-30 are respectfully requested.

Applicants would appreciate the courtesy of a telephone call should the Examiner have any questions or comments with respect to this response.

Respectfully submitted,

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